

FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER <u>67190/983015</u>
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/600393
INTERNATIONAL APPLICATION NO. PCT/DE98/03771	INTERNATIONAL FILING DATE (22.12.98) 22 December 1998	PRIORITY DATES CLAIMED (14.01.98) 14 January 1998
TITLE OF INVENTION TRUBLEPROOF PROCESS INPUT AND PROCESS OUTPUT		
APPLICANT(S) FOR DO/EO/US BARTHEL, Herbert; BIRZER, Johannes; FUCHS, Heiner; KROSIGK, Hartmut von; SCHUETZ, Hartmut; SCHENK, Andreas; TRAUTH, Armin; WEBER, Karl; ZAECH, Joerg-Peter		
Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/>	This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.	
2. <input type="checkbox"/>	This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.	
3. <input checked="" type="checkbox"/>	This express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay applicable time limit set in 35 U.S.C. examination until the expiration of the 371(b) and PCT Articles 22 and 39(1).	
4. <input checked="" type="checkbox"/>	A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.	
5. <input checked="" type="checkbox"/>	A copy of the International Application as filed (35 U.S.C. 371(c)(2))	
	a. <input type="checkbox"/>	is transmitted herewith (required only if not transmitted by the International Bureau).
	b. <input checked="" type="checkbox"/>	has been transmitted by the International Bureau.
	c. <input type="checkbox"/>	is not required, as the application was filed in the United States Receiving Office (RO/US)
6. <input checked="" type="checkbox"/>	A translation of the International Application into English (35 U.S.C. 371(c)(2)).	
7. <input checked="" type="checkbox"/>	Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))	
	a. <input type="checkbox"/>	are transmitted herewith (required only if not transmitted by the International Bureau).
	b. <input type="checkbox"/>	have been transmitted by the International Bureau.
	c. <input type="checkbox"/>	have not been made; however, the time limit for making such amendments has NOT expired.
	d. <input checked="" type="checkbox"/>	have not been made and will not be made.
8. <input type="checkbox"/>	A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).	
9. <input checked="" type="checkbox"/>	An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unsigned)	
10. <input checked="" type="checkbox"/>	A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).	
Items 11. to 16. below concern other document(s) or information included:		
11. <input checked="" type="checkbox"/>	An Information Disclosure Statement under 37 CFR 1.97 and 1.98.	
12. <input type="checkbox"/>	An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included	
13. <input checked="" type="checkbox"/>	A FIRST preliminary amendment.	
	<input type="checkbox"/>	A SECOND or SUBSEQUENT preliminary amendment.
14. <input type="checkbox"/>	A substitute specification.	
15. <input type="checkbox"/>	A change of power of attorney and/or address letter.	
16. <input checked="" type="checkbox"/>	Other items or information: Preliminary Examination Report, Search Report and PCT/RO/101.	

Express Mail No.:

EL594604576US

U.S. APPLICATION NO. (If known, see 37 CFR 1.15) 09/600393		INTERNATIONAL APPLICATION NO PCT/DE98/03771	ATTORNEY'S DOCKET NUMBER 67190/983015
17. <input checked="" type="checkbox"/> The following fees are submitted:		CALCULATIONS PTO USE ONLY	
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO \$840.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) ... \$670.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$760.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$970.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$96.00			
ENTER APPROPRIATE BASIC FEE AMOUNT =		\$ 840	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		\$	
Claims	Number Filed	Number Extra	Rate
Total Claims	6 - 20 =	0	X \$18.00
Independent Claims	2 - 3 =	0	X \$78.00
Multiple dependent claim(s) (if applicable)		+ \$260.00	\$
TOTAL OF ABOVE CALCULATIONS =		\$ 840	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).		\$	
SUBTOTAL =		\$ 840	
Processing fee of \$130.00 for furnishing the English translation later the <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).		+	\$
TOTAL NATIONAL FEE =		\$ 840	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property		+	\$
TOTAL FEES ENCLOSED =		\$ 840	
		Amount to be: refunded	\$
		charged	\$
a. <input type="checkbox"/> A check in the amount of \$_____ to cover the above fees is enclosed. b. <input checked="" type="checkbox"/> Please charge my Deposit Account No <u>11-0600</u> in the amount of \$840.00 to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to <u>11-0600</u> . A duplicate copy of this sheet is enclosed.			
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a)) Deposit Account No. or (b)) must be filed and granted to restore the application to pending status.			
<i>By: Richard L. Mayer, Reg. No. 41,172</i> <i>Richard L. Mayer</i> SIGNATURE			
Kenyon & Kenyon One Broadway New York, New York 10004		Richard L. Mayer, Reg. No. 22,490 NAME <i>7/14/00</i> DATE	

09/600393

534 Rec'd PCT/PTC 14 JUL 2000
EXPRESS MAIL CERTIFICATE

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DATE OF DEPOSIT July 14, 2000

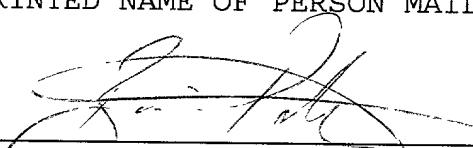
TYPE OF DOCUMENT National Phase Application

SERIAL NO. Revised FILING DATE 14/07/2000

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09/600393

[67190/983015]

534 Rec'd PCT/PTC 14 JUL 2000
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s) : Herbert BARTHEL et al.
Serial No. : To Be Assigned
Filed : Herewith
For : TROUBLEPROOF PROCESS INPUT AND PROCESS
OUTPUT
Examiner : To Be Assigned
Art Unit : To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

SIR:

Kindly amend the above-identified application before
examination, as set forth below.

IN THE DRAWINGS:

Please amend the drawings as indicated on the
attached red-marked sheets.

IN THE SPECIFICATION:

Please amend the specification as follows:

On page 1, before line 1, insert:

--FIELD OF THE INVENTION--.

On page 1, before line 7, insert:

--BACKGROUND INFORMATION--.

On page 1, line 12, change "previously" to --
conventionally--.

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On page 2, line 1, change "previously" to --
conventionally--.

On page 2, before line 16, insert:
--SUMMARY--.

On page 2, line 16, change "Therefore, the" to --
An--, and change "specify" to --provide--.

On page 2, line 23, before "invention" insert --
present--.

On page 2, line 37, change ", that the" to --.
The--.

On page 3, line 4, change ", that the" to --. The--.

On page 3, line 9, before "invention" insert --
present--.

On page 3, line 25, after "i.e." insert --,--.

On page 3, line 31, before "invention" insert --
present--.

On page 3, line 38, after "i.e." insert --,--.

On page 4, line 7, after "e.g." insert --,--.

On page 4, line 25, before "invention" insert --
present--.

On page 5, line 16, before "invention" insert --
present--.

On page 5, line 24, after "e.g." insert --,--.

On page 7, delete lines 4-11, and insert:

--BRIEF DESCRIPTION OF THE DRAWINGS--.

On page 7, line 14, change ";" to ----.

On page 7, line 16, change ";" and" to ----.

On page 7, before line 20, insert:

--DETAILED DESCRIPTION--.

On page 7, line 22, after "e.g." insert ---,--.

On page 10, line 4, after "e.g." insert ---,--.

On page 11, delete line 1, and insert:

--What Is Claimed Is--.

IN THE ABSTRACT:

Please amend the Abstract as follows.

Line 3, change "specified" to --described--.

Line 7, change ", the method being characterized in that" to --. In the method,--.

Line 9, delete "(EE)".

Line 10, delete "(AE)", change ", and that" to --. At--, and delete "(EE)".

Line 11, delete "(T)" and "(AE)".

Line 12, change ", and that the" to --. The--, and delete "(T)".

Line 13, delete "(TN)".

Line 14, delete "(TT)" and "(AE)".

Line 15, delete "(TS)" and "(EE)".

Line 16, delete "(AE)".

Line 17, delete "(T)".

Delete line 21.

IN THE CLAIMS:

Please cancel claims 1-7 in the underlying PCT application, without prejudice. Please also cancel, without prejudice, claims 1-6 in the annex to the International Preliminary Examination Report ("IPER").

Please add the following new claims:

7. (New) A failsafe data input device, comprising:

at least one input channel for connecting peripheral sensors;

a test circuit that triggers a test procedure at predetermined times to effect a status change for at least one of the input channels; and

internal logic monitoring the status change and outputting an error message, the status change effected by the test circuit being canceled at an end of the test procedure, the test procedure being completely transparent for reading out an affected input channel.

8. (New) The failsafe data input device according to claim 7, wherein the at least one input channel is antivalent.

9. (New) A failsafe data output device, comprising:

at least one output channel for connecting peripheral actuators; and

a processing unit to process a user-designed logic operation, the processing unit evaluating useful information of a received telegram, subjecting the useful information to the user-designed logic operation

and driving the at least one output channel in accordance with a result of the logic operation.

10. (New) The failsafe data output device according to claim 9, wherein the processing unit monitors a time sequence of process data transmitted with the useful information and drives the at least one output channel only when the time sequence of data for driving the at least one output channel lies within predetermined tolerances.

11. (New) The failsafe data output device according to claim 9, further comprising:

a monitoring circuit constructed as a watchdog, the monitoring circuit to monitor the processing unit and shifting the at least one output channel into a safe state as soon as a malfunction of the processing unit is detected.

12. (New) The failsafe data output device according to claim 11, wherein the at least one output channel includes a readback output channel, wherein a signal supplied to the readback output channel is also supplied to the monitoring circuit, the monitoring circuit comparing the supplied signal and a signal read back from the readback channel and, in response to deviations, shifts an affected output channel or all of the at least one output channels into a safe state.

Remarks

This Preliminary Amendment cancels, without prejudice, claims 1-7 in the underlying PCT application. This Preliminary Amendment further cancels, without prejudice, claims 1-6 in the annex to the IPER, and adds new claims 11-20. The new claims, *inter alia*, conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

The above amendments to the drawings, the specification and the abstract conform the drawings, the specification and the abstract to U.S. Patent and Trademark

Office rules, and do not introduce new matter into the application.

The underlying PCT application PCT/DE98/03771 includes an International Search Report dated May 18, 1999. An English translation of the Search Report is provided herewith.

The underlying PCT application also includes an International Preliminary Examination Report ("IPER"), dated April 7, 2000. An English translation of the IPER and the annex thereto is included herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

By: Richard L. Mayer (Reg. No. 41,172)

Dated: 7/14/00

By: Richard L. Mayer
Richard L. Mayer
Reg. No. 22,490

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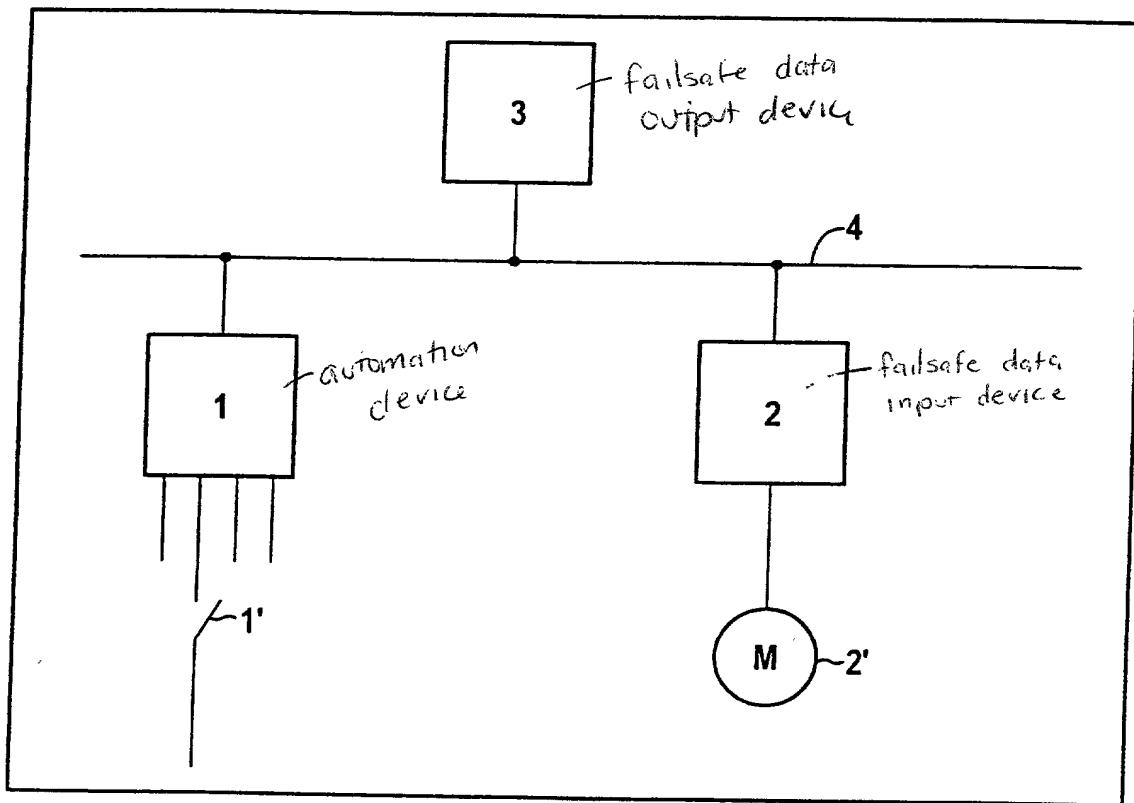


FIG 1

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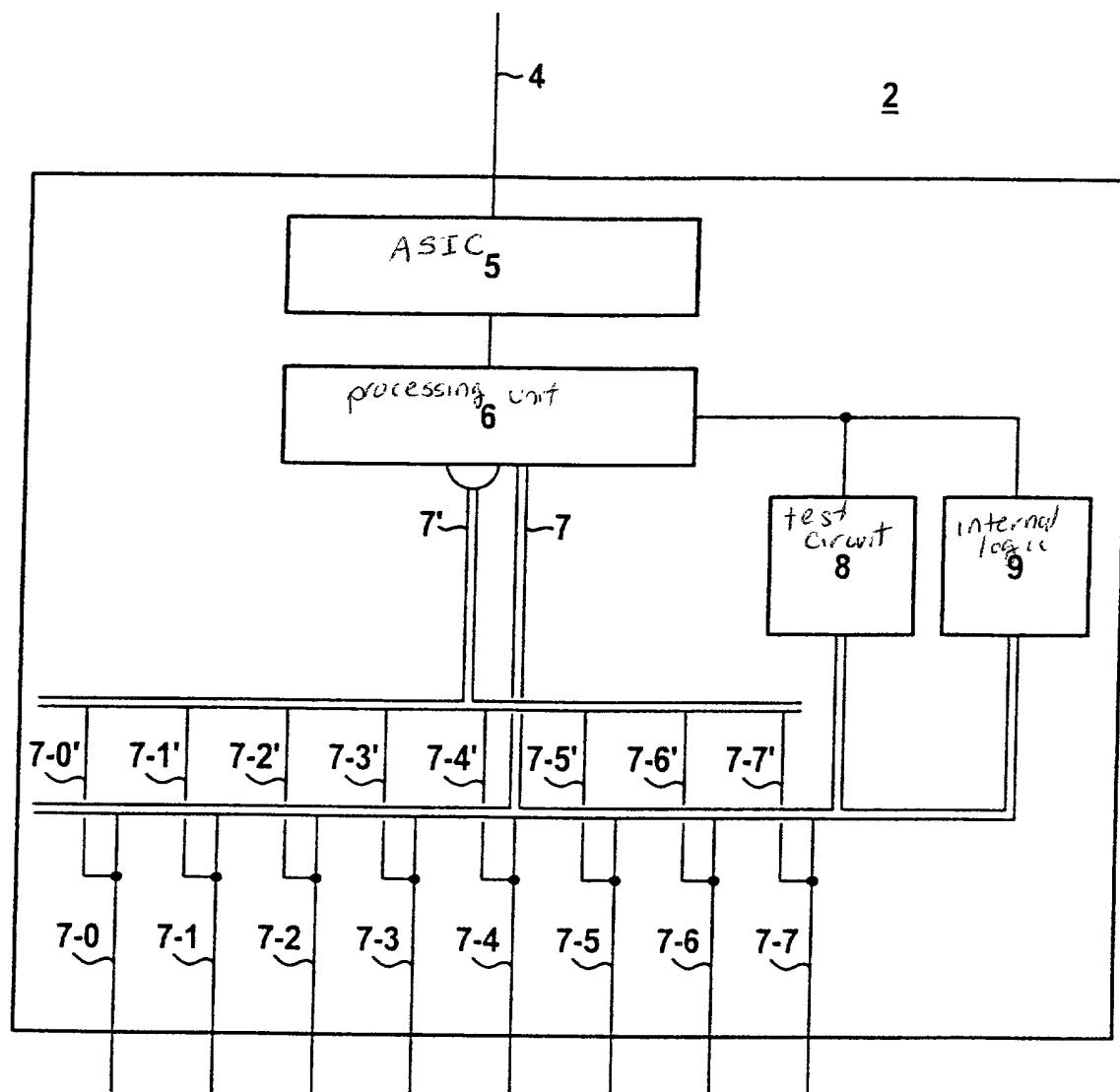


FIG 2

3/3

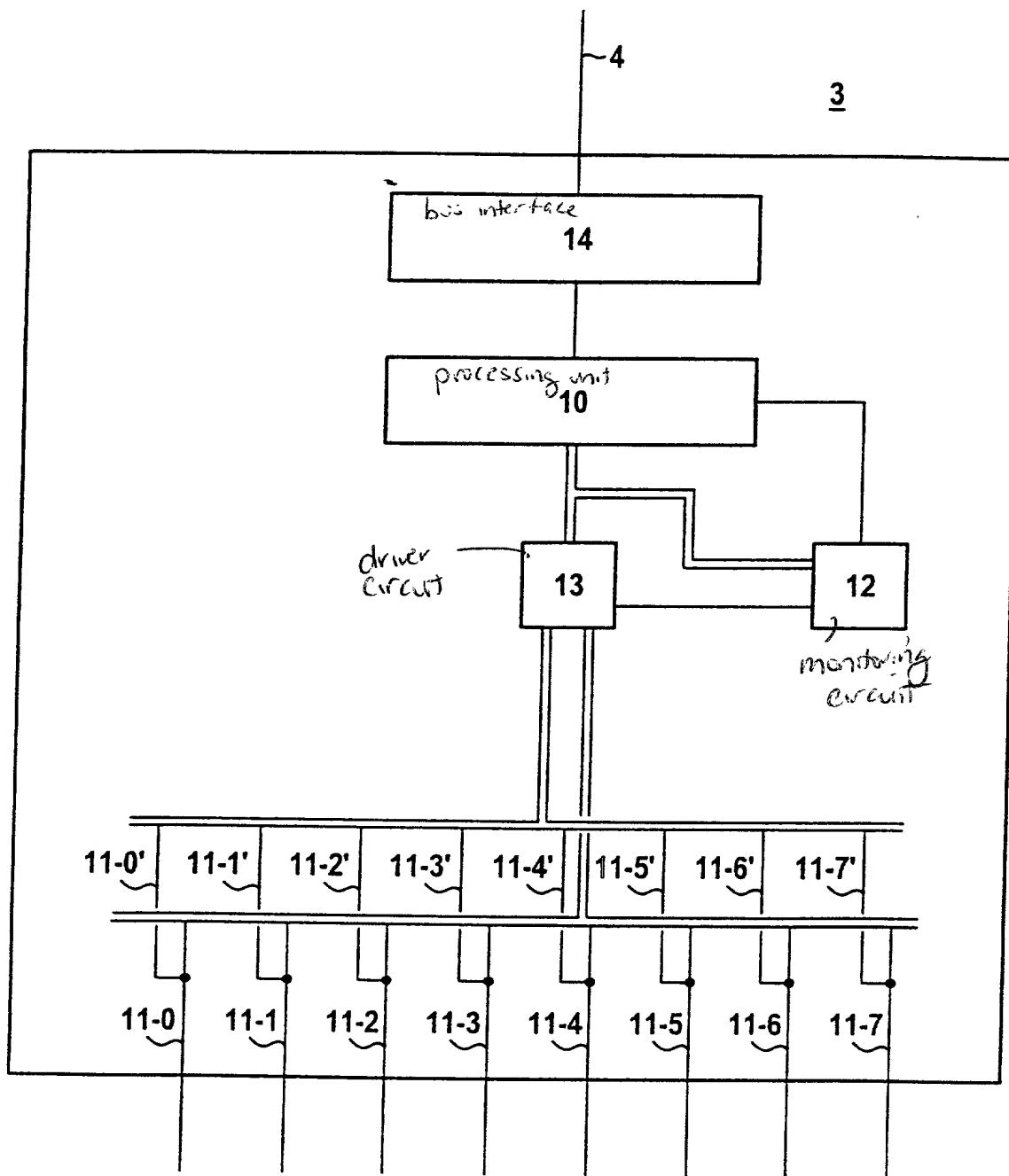


FIG 3

TROUBLEPROOF PROCESS INPUT AND PROCESS OUTPUT

The present invention relates to a method for operating an automation system that has at least one input unit for receiving process signals and at least one output unit for driving external peripherals, the input unit and the output unit being communicatively interconnected via a bus.

To achieve rapid shutdown of the automated processes or individual operations in emergency situations when working with automation projects which are controlled and/or monitored by an automation system of this type, an emergency-stop arrangement in the form of an emergency-stop chain has previously been provided.

Emergency-stop switches, light gratings, tread mats or the like are integrated into such an emergency-stop chain. Due to the demands to be made on an emergency-stop arrangement, it is usually designed in conventional wiring. A tunnel furnace which is subdivided into a number of segments with respect to the automation process can be mentioned here as an example. At user-accessible positions on the outside of the tunnel furnace, emergency-stop buttons, for example, are provided for the emergency-stop arrangement, the operation of an emergency-stop button entailing, for example, the defined shutting-down of the entire process depending on the design of the overall automated system.

The emergency-stop buttons are field devices having an input function. Correspondingly, the devices shutting down the process are devices having an output function for driving external peripherals, thus, for example, output devices which control a motor for transport processes, a motor for ventilation, an hydraulic unit for positioning or the like.

In the event of an emergency-stop situation, the external peripherals must be disconnected immediately. For this

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purpose, an emergency-stop chain which previously had to be constructed in conventional wiring and which, in response to the operation of an emergency-stop button, effects an immediate shutdown of the motor or an immediate shutdown of 5 the hydraulic unit, is set up between the input devices, that is to say, the emergency-stop buttons, and the output devices such as the motors or the units. The conventional wiring has been necessary till now due to the safety demands to be made on an emergency-stop arrangement.

10

In this connection, however, it is disadvantageous to provide the conventional wiring in the entire process field when working with large-area automation projects such as the tunnel furnaces described.

15

Therefore, the object of the present invention is to specify a method for operating an automation system in which it is possible to dispense with the conventional wiring for dealing with emergency-stop situations, and instead a communicative 20 connection exists between the components of the emergency-stop chain via the bus of the automation system.

According to the invention, therefore, the conventional wiring for the emergency-stop arrangement is omitted, and all field 25 devices, i.e., thus also the emergency-stop buttons and the motors or units to be integrated into the emergency-stop chain, are communicatively connected via the process bus.

This objective is achieved for a method for operating an 30 automation system, wherein the automation system has at least one input unit for receiving process signals and at least one output unit for driving external peripherals, and wherein the at least one input unit and the at least one output unit are communicatively interconnected via a bus, in that at least one 35 of the input units and at least one of the output units are constructed as a failsafe input unit and as a failsafe output unit, respectively, that the failsafe input unit transmits a data item to the failsafe output unit at predetermined times,

that the data item includes at least one useful information item, one destination point code designating the addressed output unit and one origin code designating the transmitting input unit, that the output unit interprets the continuous 5 reception of the data item as an indication of an intact communication relationship, and otherwise shifts the connected peripherals into a safe state.

According to the invention, the safety demands to be made on 10 an emergency-stop arrangement are met if the input devices, i.e., for example, the emergency-stop buttons and the output devices that are to be integrated into the emergency-stop chain and are provided for driving the motors or units, are in each case constructed to be failsafe. In the event of an 15 emergency-stop situation, the following sequence then occurs in the automated system:

In response to the operation of an emergency-stop button, a data item is placed on the bus by the data input device.

20 According to the specifications of the bus protocol used for the physical communications link, the data item to be transmitted includes at least one useful information item, in this case therefore the information as to whether the emergency-stop button has been pressed or not, at least one 25 destination address, i.e. the address of the communication partner to which the message is sent - a special identifier enabling the message to be sent to all communication partners - and, finally, the origin code which identifies the sender of the data item.

30 The invention can then be used, on the one hand, in such a manner that the data item is sent to a quite specific communication partner, the addressee recognizing from the destination address contained in the data item that the data 35 item is intended for it, or the data item is sent to all communication partners, each individual communication partner determining from the origin address of the data item whether the data item, i.e. the useful information in the data item,

is to be evaluated by it.

On the other hand, the data item can also be sent to a higher-level unit of the automation system, e.g. the central
5 processing unit of a programmable controller, the latter in turn recognizing from the origin code of the data item that a message, e.g. from an emergency-stop button, has arrived which needs immediate handling, so that immediately after detecting the data item, the central processing unit forwards it to the
10 output devices so that they trigger a deceleration or shutdown of the motors or units connected to the output devices, or they themselves transmit a further data item to the output devices which leads to the same result.

15 In this context, the output unit interprets the continuous reception of the data item from the input unit as indication of an intact communication relationship. In the case when the output unit detects that a data item from an input unit fails to appear during a time span which is greater than a
20 predetermined time span, the output unit shifts the connected peripherals into a safe state and thus ensures again that the connected motors or units are shut down.

For use within the framework of the method according to the
25 invention for operating an automation system, provision is also made for a failsafe data input device having at least one input channel for connecting peripheral sensors, the data input device being provided with a test circuit which triggers a test procedure at predetermined times and, in so doing,
30 effects a status change for at least one of the input channels of the failsafe input device, an internal logic monitoring the status change and, if necessary, outputting an error message, the status change effected by the test circuit being canceled again at the end of the test procedure, and the test procedure
35 being completely transparent for reading out the affected input channel.

Furthermore or as an alternative, a failsafe data input device

having at least one input channel for connecting peripheral sensors, in which the at least one input channel is designed to be antivalent, is provided for use within the framework of the method according to the invention for operating an
5 automation system.

Due to the above-mentioned measures, i.e. due to the antivalent design of the input channel or due to the monitoring of the input channel by a test circuit, the
10 failsafe input devices designed in accordance with the above description become failsafe data input devices, it also being possible to combine the two measures.

Furthermore, an output unit constructed as a failsafe output device is provided for use within the framework of the method according to the invention for operating an automation system. If a processing unit for processing user-designable logic operations is provided for the failsafe data output device, where the processing unit evaluates the useful information of
15 a received data item, subjects the useful information to the user-designable logic operation and drives the at least one output channel in accordance with the result of the logic operation, software components which were previously usually provided in a higher-level automation device, e.g. the central
20 processing unit of a programmable controller, are also
25 displaceable into the failsafe output device, so that in this case especially fast and effective processing and evaluation of the logic operations is possible.

30 If for the failsafe data output device, the processing unit furthermore or alternatively monitors the time sequence of the process data transmitted with the useful information and drives the at least one output channel only if the time sequence of the data required for driving the output channel
35 lies within predetermined tolerances, then a so-called muting is possible which contributes to increasing the reliability of the automated process. The protection of a traverser with the aid of an inductive limit switch and a

light barrier can be named as an example. When the traverser moves, it triggers both the inductive limit switch and the light barrier in a certain time sequence determined by the speed of the traverser.

5

When the time sequence of the input of the associated signals is within the predetermined tolerances, the processing can be continued. On the other hand, a person only triggers the light barrier when the additional signal of the inductive 10 limit switch is absent during the predetermined tolerance time. Such a constellation can be evaluated as an alarm constellation, to which reaction is possible with an emergency-stop arrangement.

15 If the failsafe data output device is provided with a monitoring circuit, constructed as watchdog and monitoring the processing unit, which shifts the at least one output channel into a safe state as soon as a malfunction of the processing unit is detected, then a second disconnect path is established 20 via the monitoring circuit constructed as watchdog. If, for example, the processing unit were no longer capable of disconnecting a special output, then a motor or a unit, for example, would remain permanently activated without the monitoring circuit. The monitoring circuit constructed as 25 watchdog detects such states and, upon detecting, switches the outputs into a safe state.

If, in the failsafe data output device, the output channel, which can be driven by the processing unit, is constructed as 30 a readback output channel, if the signal which can be supplied to the output channel can also be supplied to the monitoring circuit, and if the monitoring circuit compares the signal supplied to it and the signal read back from the output channel and, in response to deviations, shifts the affected 35 output channel or even all the output channels and the peripherals connected thereto into a safe state, then discrepancies in the driving of the respective output channels are detected and they are immediately shifted

into a safe state.

Other features, advantages and possible applications of the
5 present invention come to light from the subclaims, the
following description of exemplary embodiments with reference
to the drawing, and the drawing itself. In this context, all
features described and/or represented pictorially, alone or in
any combination, form the subject matter of the present
10 invention, regardless of the way in which they are combined in
the patent claims or their antecedents. In the drawing:

Figure 1 shows a simplified block diagram of an automation
system;

15 Figure 2 shows a block diagram of a failsafe data input
device; and

Figure 3 shows a block diagram of a failsafe data output
device.

20 In Figure 1, a block diagram of a simple automation system
having a failsafe data input device 2, a failsafe data output
device 3 and a higher-level automation device 1, e.g. central
processing unit 1 of a programmable controller, is shown by
way of example. The devices are communicatively interconnected
25 via a bus 4, preferably via a bus 4 suitable for use in
industrial environments, especially the profi process field
bus 4.

Failsafe data input device 2 is connected to an emergency-stop
30 button 1'. Failsafe data output device 3 is connected to a
motor 2'. When emergency-stop button 1' is operated, data
input device 2 receives this signal, transmits it via bus 4 to
data output device 3 which thereupon effects the shutdown of
motor 2'.

35

Figure 2 shows a block diagram of a first embodiment of a
failsafe data input device 2. Failsafe data input device 2 is
communicatively connected via bus 4 to other devices 1, 2, 3

linked to bus 4, the bus interface being effected by a bus ASIC 5. The functions of data output device 3 are effected by a processing unit 6 which, for example, is an ASIC or a microprocessor. Input channels 7-0, 7-1...7-7 are supplied 5 directly or indirectly to processing unit 6.

Also provided in data input device 2 is a test circuit 8 which is likewise controlled by processing unit 6 and which triggers a test procedure at predetermined times and, in so doing, 10 effects a status change for at least one of input channels 7-0, 7-1...7-7 of failsafe data input device 2. This status change is monitored by an internal logic 9 which outputs an error message if the status change triggered by test circuit 8 has no effect on the status of the respective input channel 7-15 0,

7-1...7-7. At the end of the test procedure, the status change effected by test circuit 8 is canceled again. In this context, the test procedure is completely transparent for reading out the affected input channels 7-0, 7-1...7-7 during normal 20 operation of failsafe data input device 2.

Furthermore, if inputs 7-0, 7-1...7-7 are also supplied in negated form 7-0', 7-1'...7-7' to processing unit 6, the input channels are designed to be antivalent. Processing unit 6 then 25 reads the status, e.g. logical 0, for the input channel in question, e.g. 7-2, and as negated status for antivalent corresponding input 7-2', the corresponding complement, thus logical 1 in this case. Malfunctions during the forwarding of the statuses of the respective input channels can then be 30 detected simply and reliably by processing unit 6 by checking in each case whether complementary statuses are present on the respective input channel and on the input channel antivalent thereto.

35 Figure 3 shows a block diagram of a failsafe data output device 3 which is connected to process bus 4 by a bus ASIC 14 constructed as bus interface 14. Failsafe data output device 3 has a processing unit 10 for processing user-designable logic

operations, processing unit 10 evaluating useful information TN of a message received via process bus 4, subjecting useful information TN to the user-designable logic operation and driving the at least one output channel 11-0, 11-1... 11-7 in 5 accordance with the result of the logic operation.

In the illustration according to Figure 3, failsafe data output device 3 has a monitoring circuit 12 constructed as watchdog 12 and monitoring processing unit 10, said monitoring 10 circuit shifting the at least one output channel 11-0, 11-1...11-7 into a safe state as soon as a malfunction of processing unit 10 is detected. For this purpose, monitoring circuit 12 monitors the functioning of processing unit 10, the statuses of the respective output channels 11-0, 11-1... 11-7 15 being determined by monitoring circuit 12 in the event processing unit 10 malfunctions, for which purpose a driver circuit 13 is provided which can be driven both by processing unit 10 and by monitoring circuit 12.

20 If processing unit 10 malfunctions, the driving, output by monitoring circuit 12, of the respective output channels 11-0, 11-1...11-7 overwrites the respective driving by processing unit 10 which has already been detected as faulty at this time.

25

In the illustration according to Figure 3, failsafe data output device 3 is also constructed in such a manner that output channel 11-0, 11-1... 11-7, which can be driven by the 30 processing unit, is constructed as readback output channel 11-0', 11-1'... 11-7', that the signal which can be supplied to output channel 11-0, 11-1...11-7 can also be supplied to monitoring circuit 12, that monitoring circuit 12 compares the signal supplied to it and signal 11-0', 11-1'...11-7' read 35 back from the output channel and, in response to deviations, shifts the affected output channel 11-0, 11-1 ...11-7 into a safe state.

In the above description, the assumption is always input and output devices 2, 3 having in each case eight input and output channels, respectively. Naturally, the number of channels can also be greater or less than eight, e.g. 16 or 32.

Patent Claims

1. A method for operating an automation system,
-the automation system having at least one input unit for receiving process signals and at least one output unit for driving external peripherals which are communicatively interconnected via a bus,
characterized in that

- at least one of the input units and at least one of the output units are constructed as failsafe input unit (EE) and failsafe output unit (AE), respectively;
- the failsafe input unit (EE) transmits a telegram (T) to the failsafe output unit (AE) at predetermined times;
- the telegram (T) includes at least one useful information item (TN), one destination point code (TT) designating the addressed output unit (AE) and one origin code (TS) designating the transmitting input unit (EE);
- the output unit (AE) interprets the continuous reception of the telegram (T) as an indication of an intact communication relationship, and otherwise shifts the connected peripherals into a safe state.

2. A failsafe data input device having at least one input channel for connecting peripheral sensors for use in a method for operating an automation system as recited in Claim 1, characterized in that a test circuit is provided which triggers a test procedure at predetermined times and, in so doing, effects a status change for at least one of the input channels of the failsafe data input device, an internal logic monitoring the status change and, if necessary, outputting an error message, the status change effected by the test circuit being canceled again at the end of the test procedure, and the test procedure being completely transparent for reading out the affected input channel.

3. A failsafe data input device having at least one input channel for connecting peripheral sensors for use in a method for operating an automation system as recited in Claim 1,

characterized in that the at least one input channel is designed to be antivalent.

4. A failsafe data output device having at least one output channel for connecting peripheral actuators for use in a method for operating an automation system as recited in Claim 1,

characterized in that a processing unit is provided for processing user-designable logic operations, the processing unit evaluating the useful information (TN) of a received telegram (T), subjecting the useful information to the user-designable logic operation and driving the at least one output channel in accordance with the result of the logic operation.

5. The failsafe data output device as recited in Claim 4, characterized in that the processing unit monitors the time sequence of the process data transmitted with the useful information (TN) and drives the at least one output channel only when the time sequence of the data required for driving the output channel lies within predetermined tolerances.

6. The failsafe data output device as recited in Claim 4 or 5, characterized in that a monitoring circuit constructed as watchdog and monitoring the processing unit is provided, the monitoring circuit shifting the at least one output channel into a safe state as soon as a malfunction of the processing unit is detected.

7. The failsafe data output device as recited in Claim 6, characterized in that the output channel, which can be driven by the processing unit, is constructed as a readback output channel, that the signal which can be supplied to the output channel can also be supplied to the monitoring circuit, that the monitoring circuit compares the signal supplied to it and the signal read back from the output channel and, in response to deviations, shifts the affected output channel or all output channels into a safe state.

Abstract

A method is specified for operating an automation system, the automation system having at least one input unit for receiving 5 process signals and at least one output unit for driving external peripherals, which are communicatively interconnected via a bus, the method being characterized in that at least one of the input units and at least one of the output units are constructed as failsafe input unit (EE) and failsafe output 10 unit (AE), respectively, and that the failsafe input unit (EE) transmits a telegram (T) to the failsafe output unit (AE) at predetermined times, and that the telegram (T) includes at least one useful information item (TN), one destination point code (TT) designating the addressed output unit (AE) and one 15 origin code (TS) designating the transmitting input unit (EE), and that the output unit (AE) interprets the continuous reception of the telegram (T) as an indication of an intact communication relationship, and otherwise shifts the connected peripherals into a safe state.

20

Figure 1

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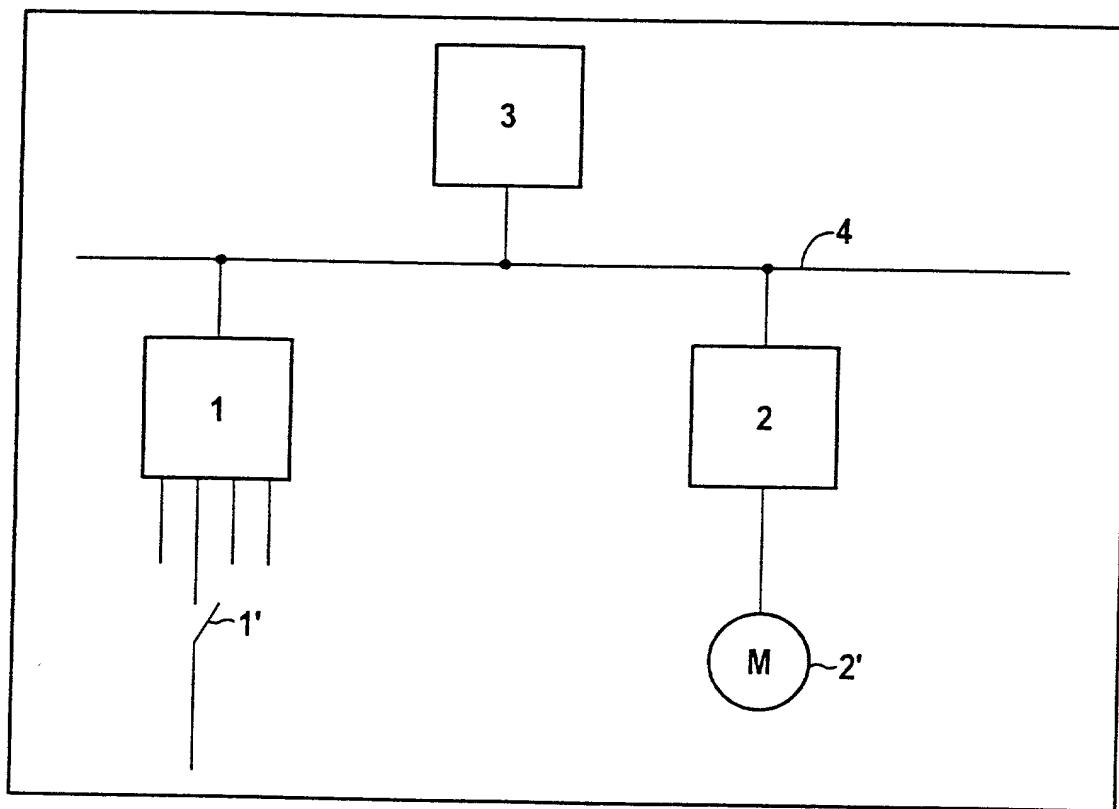


FIG 1

2/3

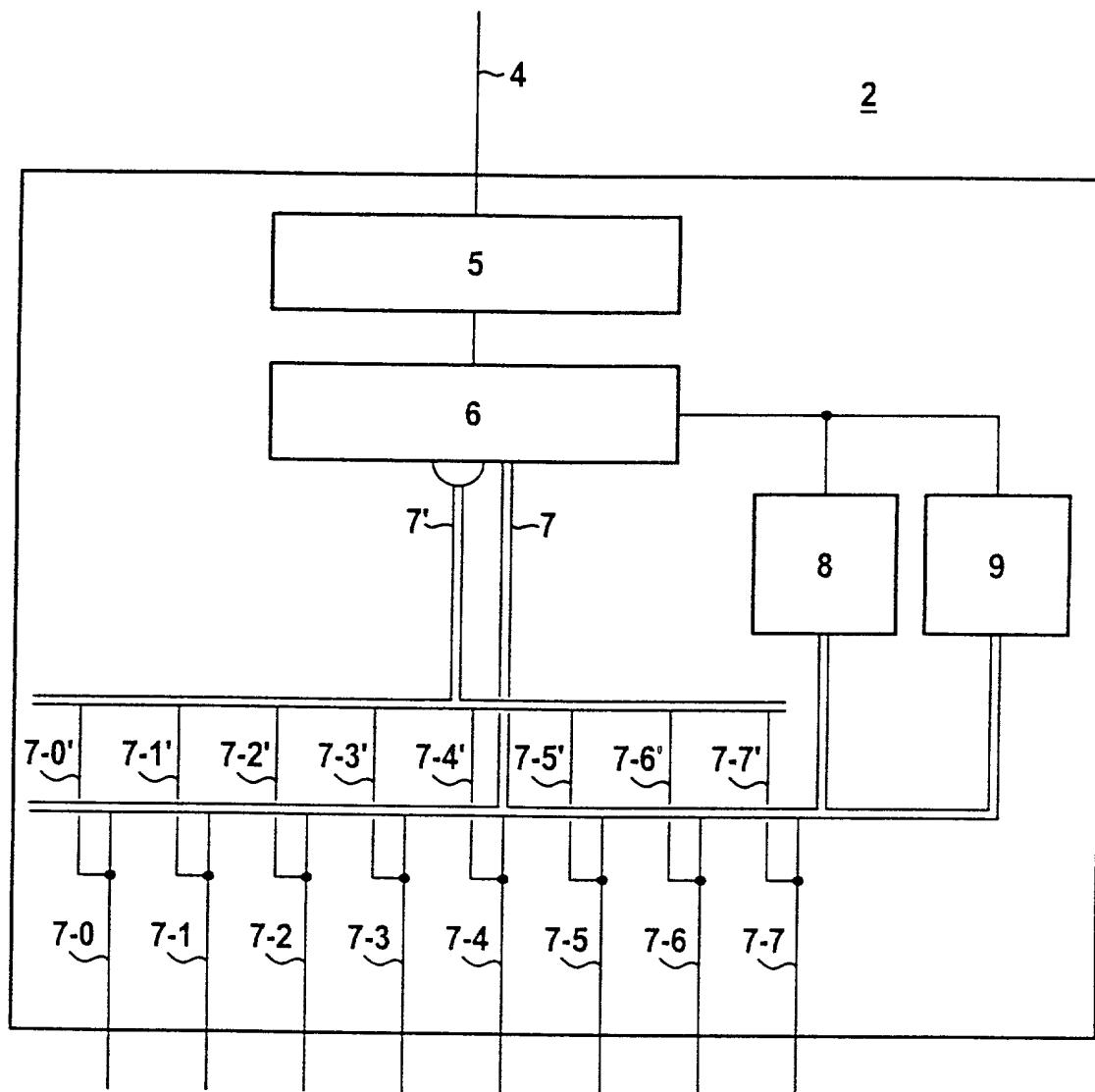


FIG 2

3/3

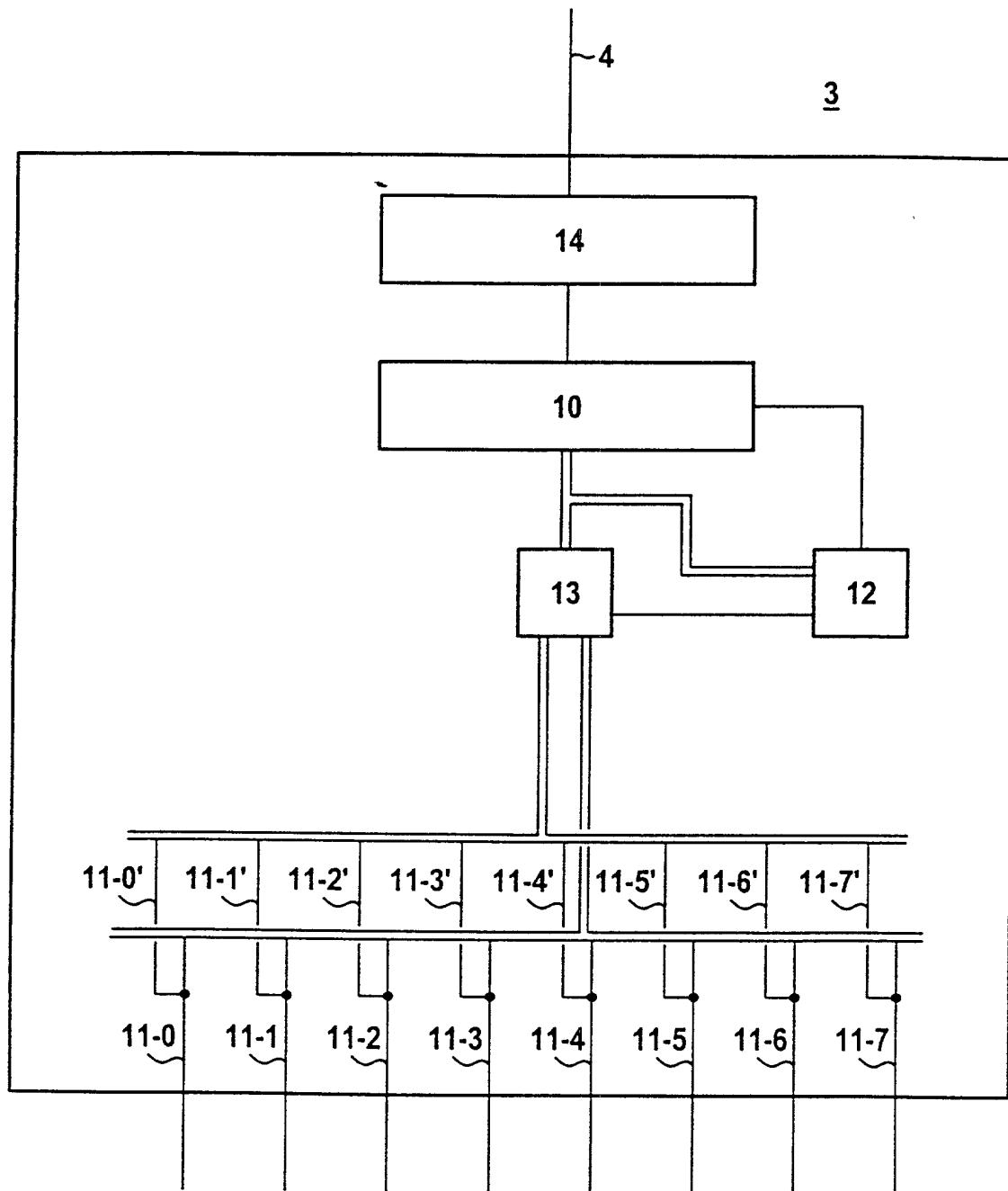


FIG 3

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **TROUBLEPROOF PROCESS INPUT AND PROCESS OUTPUT**, for which an application for Letters Patent was filed as PCT Application No. **PCT/DE98/03771** on **December 22, 1998**.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Number	Country	Day/month/year filed	Priority Claimed Under 35 USC §119
198 01 137.7	Fed. Rep. of Germany	14 January 1998	YES

EL594608255us

And I hereby appoint Richard L. Mayer (Reg. No. 22,490), Gerard A. Messina (Reg. No. 35,952), and Michelle M. Carniaux (Reg. No. 36,098) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. (3)

Please address all communications regarding this application to:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful and false statements may jeopardize the validity of the application or any patent issued thereon.

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